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Bakker et al.

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[54] **DRY-SHAVING APPARATUS WITH ANGLED BLADES**

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[73] Assignee: **U.S. Philips Corporation,** New York, N.Y.

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **30/43.6;** 30/346.51

[58] **Field of Search** 30/43.6, 43.5, 43.4, 30/43.9, 43.92, 346.51

[56] **References Cited**

U.S. PATENT DOCUMENTS

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2,375,521	5/1945	Boyd	30/43.6 X
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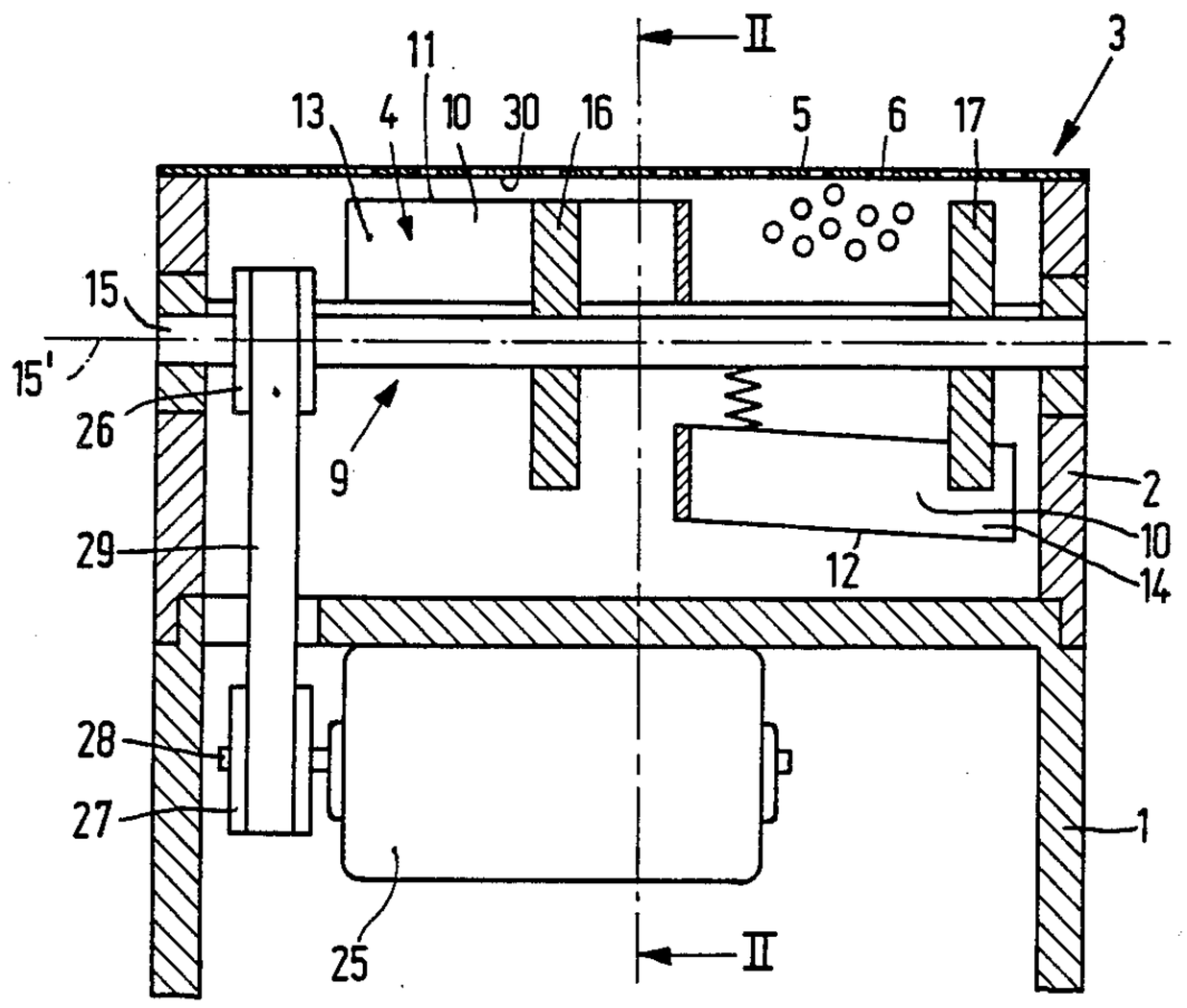
Attorney, Agent, or Firm—Thomas A. Briody; William J. Streeter; Rolf E. Schneider

[57] **ABSTRACT**

A dry-shaving apparatus comprises a housing having a holder for a shear plate with hair-entry apertures and a cutter which is rotatable about an axis of rotation and which comprises a carrier for cutting elements which are movable relative to the carrier, in which during rotation of the cutter, as part of a revolution, each point of a cutting edge at the end of a cutting element follows a constrained path which is defined by the shear plate and each point of a cutting edge follows a circular free path when the ends are clear of the shear plate. At the more advanced axial end of the first cutting element, viewed in the direction of rotation, the radius of a circular free path of the cutting edge is smaller than the distance from the axis of rotation to the corresponding portion of the shear plate at the location where at this end the free path changes into the constrained path, so that the cutter comes gradually into contact with the shear plate.

4 Claims, 4 Drawing Figures



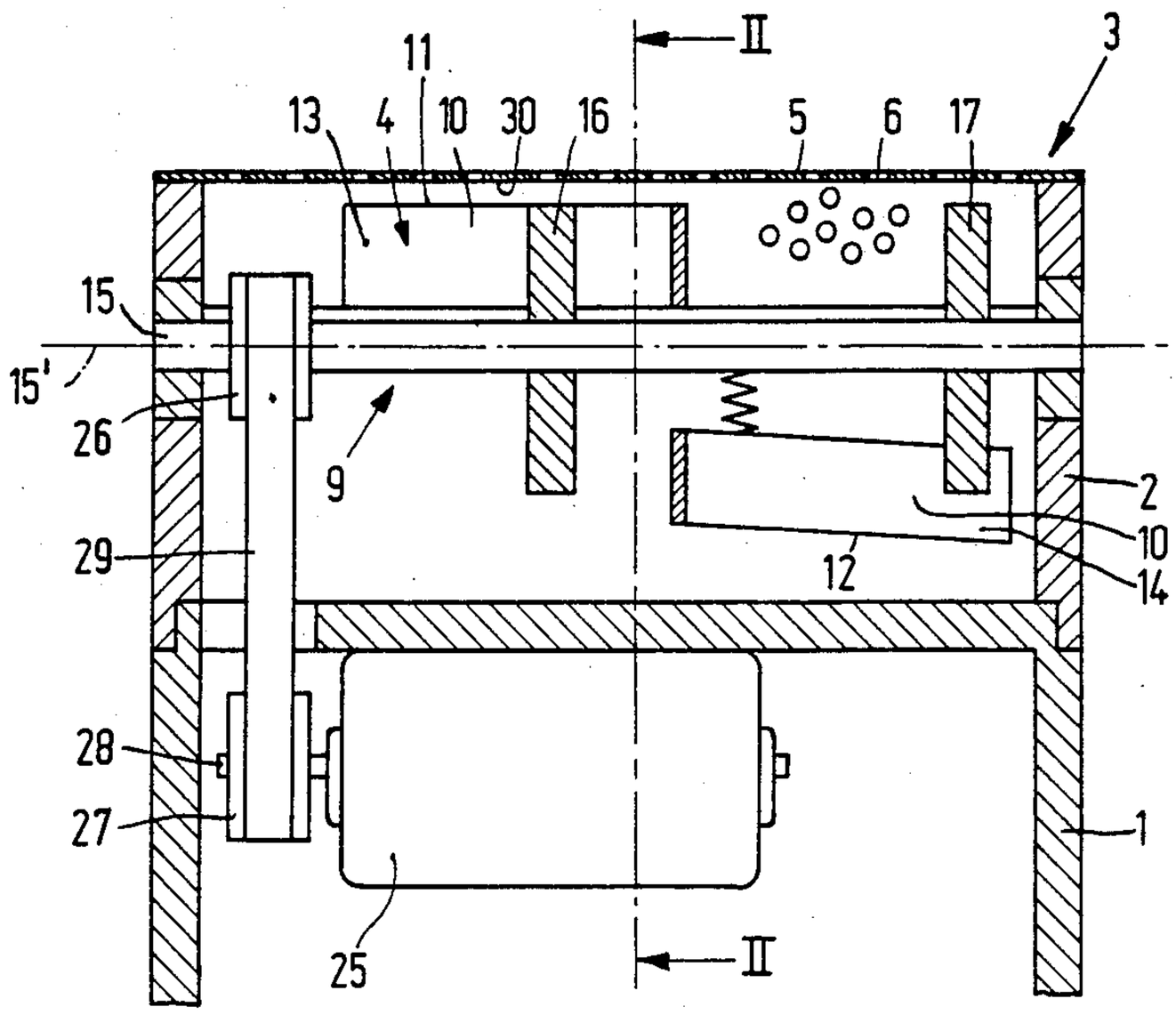
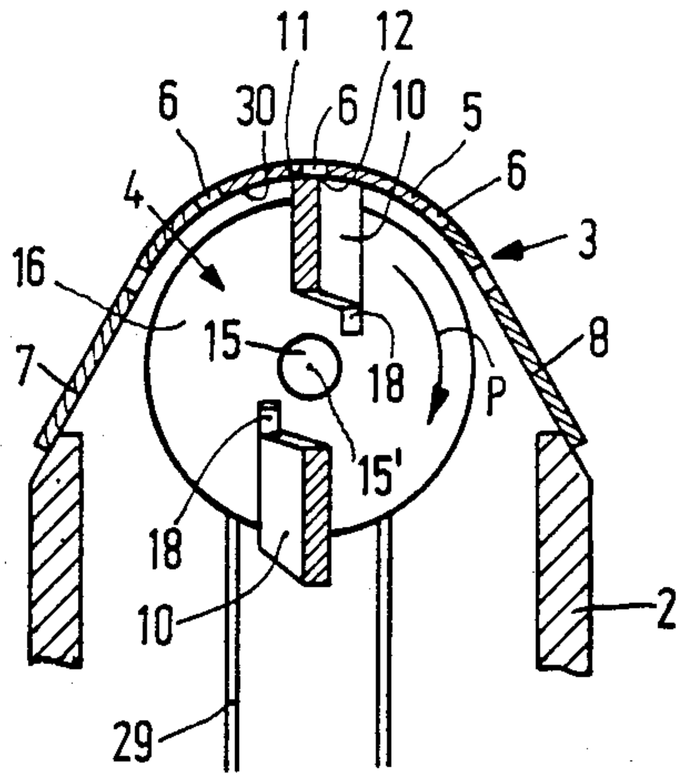

II
11
3
13
4
10
30
16
5
6
17
15
15'
26
9
2
10
14
12
29
28
27
1
25
II

FIG.1


11
12
6
30
6
10
5
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4
3
16
15
18
P
8
7
15'
18
10
2
29

FIG.2

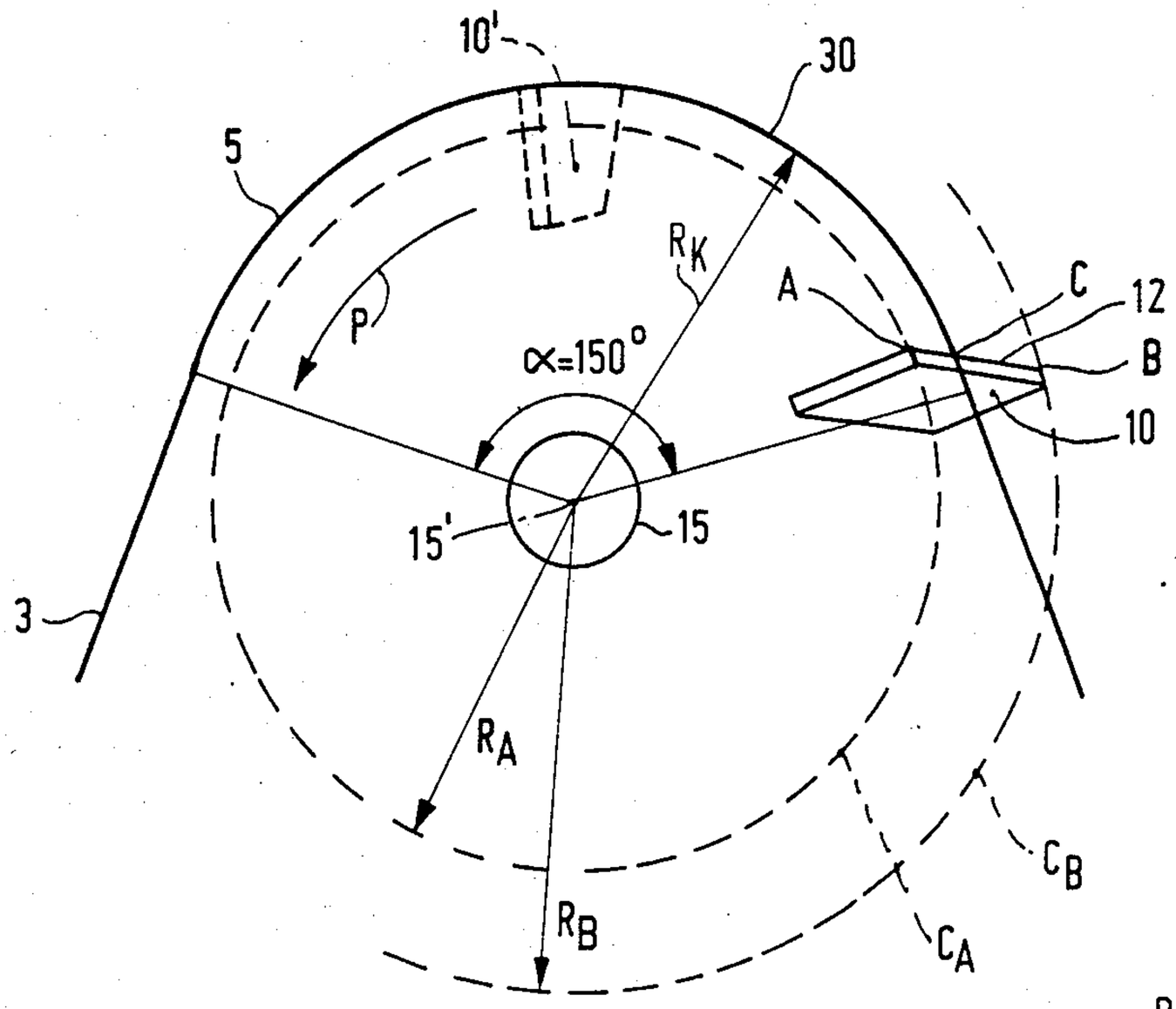
10'
30
5
R_K
A
C
12
B
10
P
∝=150°
15'
15
3
R_A
R_B
C_A
C_B

FIG. 4

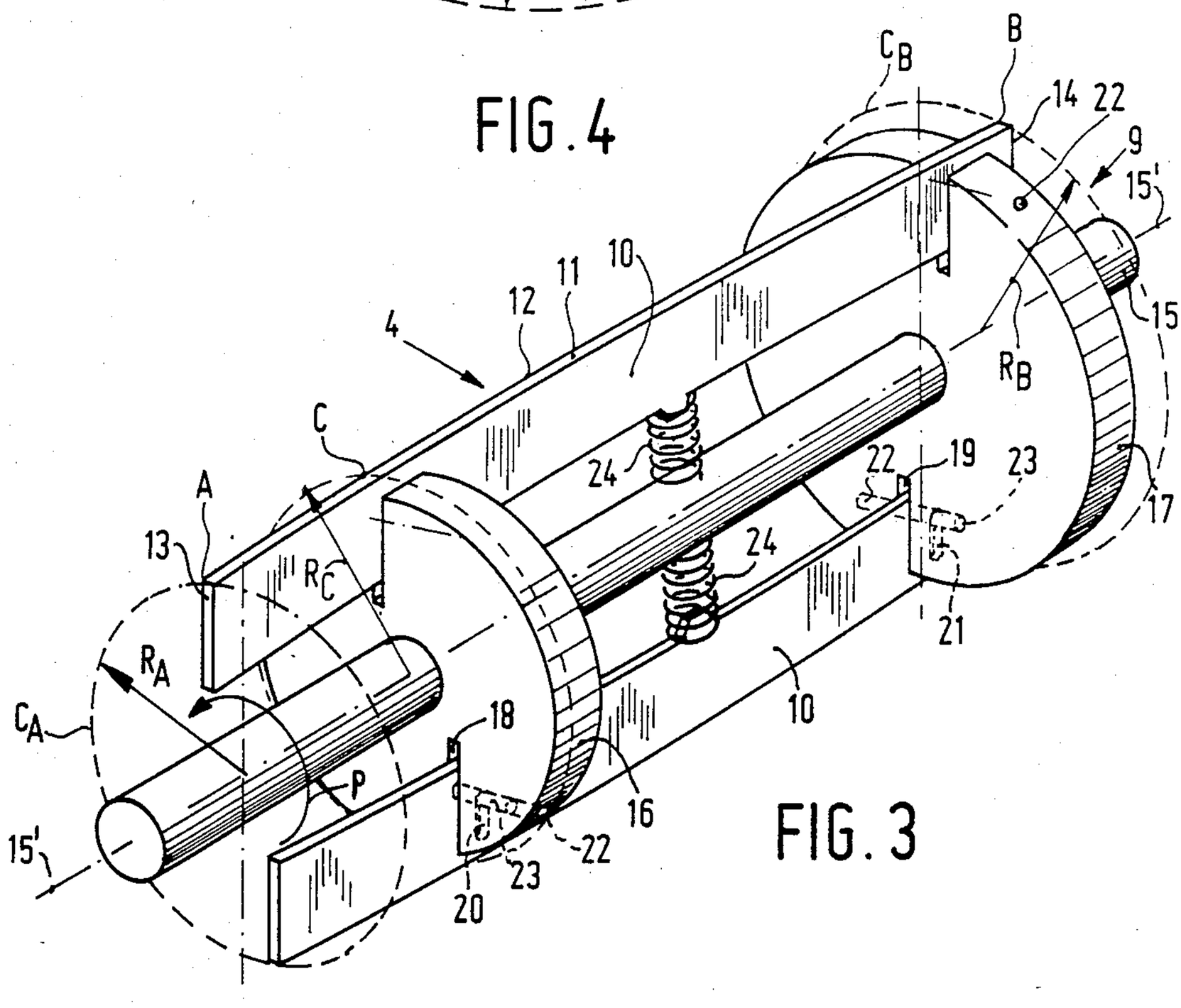
B
C_B
14
22
9
15'
15
R_B
4
12
11
10
C
24
22
19
23
17
A
13
R_C
R_A
C_A
18
P
16
10
21
15'
20
23
22

FIG. 3

DRY-SHAVING APPARATUS WITH ANGLED BLADES

The invention relates to a dry shaving apparatus comprising a housing having a holder for a shear plate formed with hair-entry apertures and a cutter which is rotatable about an axis of rotation which cutter comprises a carrier with cutting elements which are movable relative to the carrier and which at their radial ends each comprise a cutting edge which extends between two axial ends of the cutting element, one axial end being more advanced in the direction of rotation than the other axial end, and which cutter is partly surrounded by the shear plate, every point of a cutting edge at the end of a cutting element of the cutter, as it rotates, following, as part of a revolution, a constrained path defined by the shear plate and every point of a cutting edge following a circular free path about the axis of rotation when the radial ends are clear of the shear plate.

Such a dry-shaving apparatus is disclosed in for example, U.S. Pat. No. 3,710,442. At the transition where the ends of the cutting elements in this known apparatus change over from the free path to the constrained path the sudden contact between the cutting elements and the shear plate will give rise to undesired vibrations in the cutter, which may lead to damage to this cutter, the shear plate and other parts of the apparatus.

It is the object of the invention to mitigate this drawback and to this end the invention is characterized in that viewed in the direction of rotation at the more advanced axial end of the cutting element the radius of a circular free path of the cutting edge is smaller than the distance from the axis of rotation to the corresponding portion of the shear plate at the location where at said axial end the free path changes into the constrained path.

An embodiment of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings. In the drawings

FIG. **1** is a schematic longitudinal sectional view of a dry-shaving apparatus in accordance with the invention.

FIG. **2** is a part of a sectional view taken on the line II—II in FIG. **1**.

FIG. **3** is an enlarged-scale perspective view of the cutter used in the embodiment shown in FIGS. **1** and **2**.

FIG. **4** is an enlarged-scale schematic cross-sectional view similar to FIG. **2**, showing the shear plate and the cutter used in the embodiment shown in FIGS. **1** to **3**.

The dry-shaving apparatus shown in the Figures comprises a housing **1** with a holder **2** for a shear plate **3** and a cutter **4** which is rotatable relative to the shear plate and which is partly surrounded by the shear plate.

The shear plate **3** comprises a central portion **5**, curved as a circularly cylindrical surface and formed with hair-entry apertures **6** and also comprises peripheral portions **7** and **8** by which the shear plate is secured to the holder.

The cutter **4** comprises a carrier **9** and for example, two cutting elements **10** which are adjustable relative to the carrier. At its radial end **11** each cutting element **10** has a cutting edge **12** which extends between the two axial ends **13** and **14** of the cutting element.

The carrier **9** comprises a spindle **15** and two discs **16** and **17** mounted on the spindle (FIG. **3**). These discs are formed with substantially radial recesses **18** and **19** respectively for the cutting elements **10**. At the location of the discs **16** and **17** the cutting elements **10** are formed with slots **20** and **21** respectively. Pins **23** mounted in bores **22** in the discs **16** and **17** extend through the slots **20** and **21** and bridge the recesses **18**, **19**. In this way the positions of the cutting elements **10** relative to the carrier **9** are radically adjustable to a limited extent. Pressure springs **24** are arranged between the spindle **15** and the cutting elements **10** to exert outwardly directed radial forces on the cutting elements **10**.

The spindle **15** is supported in the holder **2** so as to be rotatable about the axis of rotation **15'**. The housing **1** accomodates an electric motor **25** for driving the cutter **4**. The rotation of the motor **25** is transmitted to the cutter **4** by means of pulleys **26** and **27**, mounted on the spindle **15** and the motor shaft **28** respectively, and a drive belt **29** tensioned around these pulleys.

The cutting elements **10** which are not in contact with the shear plate **3** are urged outwards by the springs **24**. The slots **20** (FIG. **3**) are shorter than the slots **21**, in such a way that the springs **24** urge the cutting elements **10** less far radially outwards at the location of the disc **16** than at the location of the disc **17**. As a result of this, the cutting edges **12** are situated on a conical surface.

The recesses **18** and **19** are offset from each other in the direction of rotation so that in the direction of rotation indicated by the arrow P the axial end **13** is more advanced than the axial end **14** of the cutting element **10**. The cutting edge **12** consequently has a helical shape.

When the cutter **4** is rotated a radial end **11** of a cutting element **10** will be in contact with the inner side **13** of the shear plate **3** during a part of a revolution (FIG. **4**). During every revolution each point of the cutting edge **12** of the cutting element **10** will therefore follow a constrained path which is determined by the shear plate **3**, and it will follow a free path when the end **11** is clear of the shear plate. This free path will be an arc of a circle having a centre situated on the axis of rotation **15'** of the spindle **15**.

The free path C_A of a point A at the end **13** of a cutting element **10** will have a radius R_A which is smaller than the radius R_B of the free path C_B of point B at the axial end **14** (see also FIG. **3**).

In FIG. **4** the free paths C_A and C_B are represented by arcs of circles shown in broken lines. The central portion of the shear plate is represented as an arc of circle **5** having a central angle α of 150° and a centre situated on the axis of rotation **15'**. The value of the radius R_K of the central portion **5** is selected to lie between the values of R_A and R_B.

For the direction of rotation P (FIG. **3**) of the cutter **4** the axial ends **13** of the cutting elements **10** are more advanced and point A is the first point reaching the central portion **5** of the shear plate **3** from the free path. Since R_A is smaller than R_K or, generally speaking, R_A is smaller than the distance from the axis of rotation **15'** of the corresponding portion of the shear plate **3** at the location where the free path at the end **13** changes over to the constrained path, point A will initially be in contact with the inner side of the shear plate. The first contact between the cutting edge **12** and the inner side **30** of the portion **5** will be obtained at the location of point C where the radius R_C of the free path is equal to R_K. As the rotation of the cutter **4** continues the pressure spring **24** will be compressed and the cutting element **10** will be tilted until the entire cutting edge **12** engages against the inner side **30** of the portion **5** of the

shear plate 3. For a cutting element 10' this position is shown in broken lines in FIG. 4. In this way a gradual contact of the cutting element with the shear plate is obtained, thereby precluding vibration and collision effects. Since every cutting element 10 is in contact with the shear plate 3 for only a part of a revolution of the cutter 4, frictional losses are minimised. It is obvious that the same result can be obtained if the helically shaped cutting edges of the cutting elements are situated on a circularly cylindrical surface and the curved portion of the shear plate has the shape of a conical surface.

What is claimed is:

1. A dry shaving apparatus comprising a housing having a holder for a shear plate formed with hair-entry apertures and a cutter which is rotatable about an axis of rotation, which cutter comprises a carrier with cutting elements which are movable relative to the carrier and which at their radial ends each comprise a cutting edge which extends between two axial ends of the cutting element, one axial end being more advanced in the direction of rotation than the other axial end, and which cutter is partly surrounded by the shear plate, every point of a cutting edge at the end of a cutting element of the cutter, as it rotates, following, as part of a revolution a constrained path defined by the shear plate and every point of a cutting edge following a circular free path about the axis of rotation when the radial ends are clear of the shear plate, characterized in that viewed in the direction of rotation at the more advanced axial end of the cutting element the radius of a circular free path of the cutting edge is smaller than the distance from the axis of rotation to the corresponding portion of the shear plate at the location where at said axial end the free path changes into the constrained path.

2. A shaving apparatus as claimed in claim 1, characterized in that in the free path the cutting edges of the cutting elements are disposed on a conical surface and the curved portion of the shear plate is shaped as a cylindrical surface.

3. A shaving apparatus as claimed in claim 1, characterized in that in the free path the cutting edges of the cutting elements are disposed on a cylindrical surface and the curved portion of the shear plate is shaped as a conical surface.

4. A shaving apparatus as claimed in claim 1, characterized in that the cutting elements are manufactured as flat components of a sheet material.

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